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The purpose of this document is to describe how to install the plot routine library developed at the Department of Automatic Control, Lund Institute of Technology in an arbitrary computer system. It discusses how to design system dependent interface routines, and to a certain degree, how the system independent routines are co-related. It will, however, not deal with how the individual system independent routines function in detail.

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Implementation Procedures for the FORTRAN Plot Library

The purpose of this document is to describe how to install the plot routine library developed at the Department of Automatic Control, Lund Institute of Technology in an arbitrary computer system. It discusses how to design system dependent interface routines, and to a certain degree, how the system independent routines are co-related. It will, however, not deal with how the individual system independent routines function in detail.

Contents

1) Introduction

The idea behind the FORTRAN Plot Library is to let all plotting take place in user defined coordinate systems, indepentendtly of the hardware environment.
To facilitate this, a set of subroutines has been defined. These subroutines constitute an interface between system dependent and application dependent parts in the sense that an arbitrary plot routine above the interface level does not have to reflect any of the characteristics of the combination computer/plotting device involved.

Each one of these plot routines performs an elementary operation of the type:

"Move the pen to a specified point on the screen", or:

"Activate the plotting device", or:

"Draw a string of characters beginning at current pen position".

Some of these routines may be called from the application programs, while others are internal to the library.

Above the interface level there exists a set of elementary plot routines, that are available to the application programmer. These routines perform the following operations:

"Initiate the current plot", or:

"Define a coordinate system/compute scale factors", or:

"Draw a visible/non-visible line", etc.

Furthermore, there exists yet another set of plot routines, i.e. compound routines to perform more elaborate operations, e.g. :

"Draw an X/Y-axis", or:

"Plot two data vectors versus each other", etc.

If you are going to implement the latter, higher level routines, then you are supposed to have read the document: "Character and String Handling in INTRAC", by Tommy Essebo, since they make use of the same basic string manipulating routines as INTRAC.

2) System Dependent Interface

The system dependent plot routines must be supplied by the receiver of the plot library. Consequently, they are here described in terms of their input parameters (I), their output parameters (O) and their behaviour.

The system dependent elements belong to one of the following categories:

a) A set of constants expressing e.g. the physical dimensions of the plotting device.

b) A number of calls to the current, basic plot package. These are the actual output operations.

Often one has a choice between several, alternate plotting devices, e.g. graphic display terminals, curve plotters, etc. It is now up to you to assign these devices to appropriate values of the device selector IDEV. E.g. IDEV=1 corresponds to the graphic terminal, IDEV=2 corresponds to the curve plotter, IDEV=3 corresponds to ..., etc.

These assignments are thereafter programmed into the interface routines:

SUBR. PLDEV
Uses IDEV (formal argument) to access the proper set of device parameters and to activate the proper device.

SUBR. PLMOVE, PLNEW, PLRSET, PLSTOP and PLSYMB
Use IDEV to branch to the correct basic, device dependent graphics software package routine. In this case IDEV is no formal parameter, but rather taken from the internal COMMON block /PLC025/, which from the interface's point of view is READ-ONLY.
Another parameter in /PLC025/ of interest is the LOGICAL switch IPFLAG: If .FALSE. the plot operation should be inhibited (applies also to SUBR. PLDEV). IPFLAG enables interactive programs with mixed graphic/non-graphic output to be run as BATCH-jobs.

```
SUBR. PLDEV(IDEV,IPFLAG,XCMAX,YCMAX,DEVSCA,CHCHGT,
            CHCWID,SYMHGT,SYMWID)
```

Initializes (activates) the plotting device, e.g. erases the screen on a graphic terminal or advances the scroll on a CALCOMP type curve plotter. It also returns the values of the size of the plot area expressed in centimetres, the size of one character in centimetres and a scale factor relating screen coordinates to centimetres.

IDEV
plot device number = 1, 2, .. (I)
IPFLAG
LOGICAL switch, if .FALSE. actual plotting on the specified device is inhibited (I)
XCMAX, YCMAX
size of plotting area in centimetres (O)
DEVSCA
scale factor relating centimetres to screen coordinates according to the relation:
X(SCREEN) = DEVSCA * X(CENTIMETRES) (O)
CHCHGT, CHCWID
height and width, respectively, for one character space plotted by SUBR. PLSYMB, expressed in centimetres (O)
SYMHGT, SYMWID
height and width, respectively, for one symbol plotted by SUBR. PLSYMB, expressed in centimetres (O)

SUBR. PLMOVE(X,Y,LDRAW)

Draws a visible/non-visible, unbroken line from the current pen position to (X,Y)

X, Y
screen coordinates (I)
LDRAW
LOGICAL plot mode flag, if .TRUE., a visible line is plotted, else a non-visible line is plotted (I)

SUBR. PLNEW

Performs ERASE (or corresponding operation)

SUBR. PLRSET

Terminates plotting temporarily. (E.g. for a graphic terminal, text mode is entered and the cursor is moved to the home position.)

SUBR. PLSTOP

Termination routine for plotting

SUBR. PLSYMB(HOLL,NHOLL)

Writes character strings on the plotting device

HOLL
vector containing text string to be output
(four characters/real variable,
the last word left justified) (I)
NHOLL
number of characters to be written (I)

the latest coord. from SUBR. PLMOVE is used
as starting point for the string (Lower Left Corner)

Note: If your basic string drawing routine needs the
current pen position as arguments, then use the
coord. pair (XLAST,YLAST) in COMMON /PLC025/.
If your basic graphics software package operates with
integer screen coord. (e.g. TEKPOINTs), then use
(IFIX(XLAST),IFIX(YLAST)) instead.
Character space height and width may be obtained from
COMMON /PLC025/ as CHCHGT and CHCWID, respectively.

3) Building a Binary Library File

All the plot routines above the interface level can be compiled straight, since they are written in standard FORTRAN IV.
For a system with a linker that sequentially scans a library file, that (part of the) library file which contains the plot routines should be sorted in the following order:

PLMAIN PLCTAB

ASPLIT ARCORN MARGIN PLINIT AREA PLLIM

MINMAX XSCAL YSCAL XYSC SCALE

LOGAX XAXIS YAXIS XYAX

LINEXY LINEY XYCURV

OFNEF

LINECM LINETO MOVECM MOVETO

XCCORD XSCORD YCCORD YSCORD

PLDEV PLMOVE PLNEW PLRSET PLSTOP PLSYMB

the self-contained INTRAC

4) Subroutine Summaries

System dependent routines are marked by an asterisc.
Internal routines are marked by a plus sign.

High Level Routines

ARCORN
: returns the corners of the chosen plotting area expressed in engineering coordinates

ASPLIT
: subdivides the plotting area, scales it and draws linear axes

LINEXY
: plots two data vectors versus each other

LINEY
: plots a data vector versus time

LOGAX
: draws a logarithmic axis

MARGIN
: defines a plotting area in terms of margins expressed in terms of character spaces

MINMAX
: finds minimal and maximal values in a data vector

XAXIS
: draws an X-axis

OFNEF+
: positions and writes a floating point number on the display

XCCORD+, YCCORD+, XSCORD+ and YSCORD+
: convert coord. between the engineering and centimetre coord. systems

XYAX+
: contains the axis-generating code common to SUBR. XAXIS and YAXIS

XYCURV+
: contains the curve-generating code common to SUBR. LINEXY and LINEY

Intermediate Level

AREA
   defines plotting area
LINECM
   draws a visible line in the centimetre coord. system
LINETO
   draws a visible line in the engineering coord. system
MOVECM
   draws a non-visible line in the centimetre coord. system
MOVETO
   draws a non-visible line in the engineering coord. system
PLINIT
   initialization routine
XSCAL
   computes scale factor and offset for the X-direction
XYSC+, SCALE+
   contains the scaling algorithms common to XSCAL and YSCAL
YSCAL
   computes scale factor and offset for the Y-direction

System Dependent Plot Interface

PLDEV*+
   parameter defining and device activating routine
PLNEW*
   defines new picture
PLMOVE*+
   elementary pen move/draw routine
PLRSET*
   terminates plotting temporarily
PLSTOP*
   termination routine
PLSYMB*
   draws a string of characters on the screen

5) Programming Considerations and Test Example

A working plot program utilizing this plot package should contain the following parts in that order:

a) a call to SUBR. PLINIT to activate the chosen plotting device and to define scale factors, offsets, limits of plotting area and plot window and character size

b) an optional call to SUBR. AREA to establish area limits according to the user's needs

c) calls to SUBR. XSCAL and YSCAL to adjust offsets and scale factors for the plot variables (expressed in engineering units) to the plotting area requested in a) or b)

d) calls to the actual pen-manipulating SUBR. LINECM, LINETO, MOVECM, MOVETO and PLSYMB or calls to SUBR. based upon these (e.g. SUBR. LINEY or XAXIS)

e) a call to SUBR. PLSTOP to deactivate the plotting device when the last coord. was processed

Optionally, calls to SUBR. PLLIM may be inserted anywhere between a) and d) to modify current plot window limits.

Note that b) + c) are memorized with the aid of COMMONs /PLC002/ and /PLC025/, so that the insertion/ removal of b) and c) does not require any update of d)

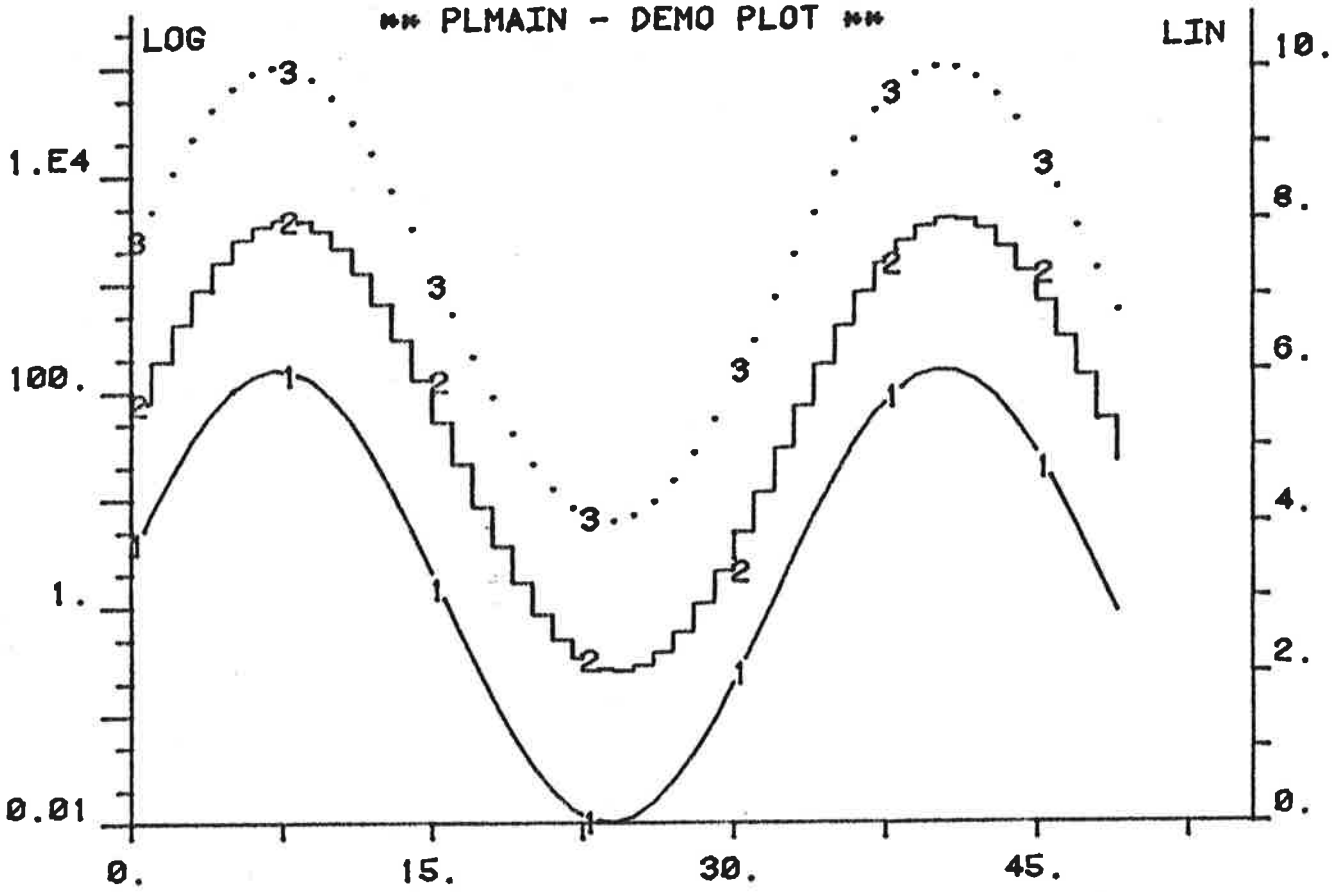
COMMONs /PLC001/, /PLC002/ and /PLC025/ should reside in memory between a) and e).

In case the output consists of several pages, these should be delimited by:

a call to SUBR. PLRSET,
a wait till a request for next page is issued and
a call to SUBR. PLNEW, in that order.

PROGR. PLMAIN is a test program written according to the above conventions. It may be used to test many

but not all of the routines. Run correctly, it will produce the enclosed figure. However the scale numbers might not be reproducible, since the scaling algorithm operates under the constraint that "harmonic" scale numbers should be written every four (two) centimetres in the horizontal (vertical) direction.



6) Cross Reference Tables

Subroutine Calls (Top-Down)

E.g. SUBR. XSCAL calls upon SUBR.s XSCORD and XYSC.

```
ARCORN: XSCORD YSCORD
AREA  :
ASPLIT: ARCORN AREA   XAXIS  XSCAL  YAXIS  YSCAL
CRENAM: HSTORV LENGTH PINT
GAC   :
HSTORV:
IMACON:
LCOMPV:
LENGTH: GAC    LCOMPV
LINECM: PLMOVE
LINETO: PLMOVE
LINEXY: XYCURV
LINEY : XYCURV
LOGAX : LINETO MOVETO OFNEF  PLSYMB XCCORD XSCORD YCCORD YSCORD
MARGIN: AREA
MINMAX:
MOVECM: PLMOVE
MOVETO: PLMOVE
OFNEF : MOVECM PFLOAT PLSYMB
PAC   :
PFLOAT: GAC    IMACON LCOMPV LOG10  PAC    PINT
PINT  : PAC
PLCTAB:
PLDEV :
PLINIT: PLDEV
PLLIM :
PLMOVE:
PLNEW :
PLRSET:
PLSTOP:
PLSYMB:
RMACON:
SCALE : RMACON
XAXIS : XYAX
XCCORD:
XSCAL : XSCORD XYSC
XSCORD:
XYAX  : LINECM MOVECM OFNEF  PLSYMB XCCORD XSCORD YCCORD YSCORD
XYCURV: CRENAM LINETO MOVETO PLSYMB XSCORD YSCORD
XYSC  : RMACON SCALE  SQRT
YAXIS : XYAX
```

```
YCCORD:
YSCAL : XYSC    YSCORD
YSCORD:
```

Subroutine Calls (Bottom-Up)

E.g. SUBR. XYSC is called by the following SUBR.s : XSCAL and YSCAL

```
ARCORN: ASPLIT
AREA  : ASPLIT MARGIN
CRENAM: XYCURV
GAC   : LENGTH PFLOAT
HSTORV: CRENAM
IMACON: PFLOAT
LCOMPV: LENGTH PFLOAT
LENGTH: CRENAM
LINECM: XYAX
LINETO: LOGAX  XYCURV
LOG10 : PFLOAT
MOVECM: OFNEF  XYAX
MOVETO: LOGAX  XYCURV
OFNEF : LOGAX  XYAX
PAC   : PFLOAT PINT
PFLOAT: OFNEF
PINT  : CRENAM PFLOAT
PLDEV : PLINIT
PLMOVE: LINECM LINETO MOVECM MOVETO
PLSYMB: LOGAX  OFNEF  XYAX   XYCURV
RMACON: SCALE  XYSC
SCALE : XYSC
SQRT  : XYSC
XAXIS : ASPLIT
XCCORD: LOGAX  XYAX
XSCAL : ASPLIT
XSCORD: ARCORN LOGAX  XSCAL  XYAX   XYCURV
XYAX  : XAXIS  YAXIS
XYCURV: LINEXY LINEY
XYSC  : XSCAL  YSCAL
YAXIS : ASPLIT
YCCORD: LOGAX  XYAX
YSCAL : ASPLIT
YSCORD: ARCORN LOGAX  XYAX   XYCURV YSCAL
```

7) COMMON Blocks

The plot package contains four COMMON blocks:

/PLC001/, /PLC002/, /PLC025/ and /XYC019/
carrying status information for the plot
package as a whole, not to be overlayed
between the calls to SUBR. PLINIT and PLSTOP.

/XYC019/, carries status information between succesive
calls to SUBR. XYCURV, must not be overlayed
during a call to either SUBR. LINEXY or LINEY.

COMMON Block References

E.g. SUBR. XYCURV references /PLC002/, /PLC025/ and /XYC019/

```
ARCORN: PLC025
AREA  : PLC025
ASPLIT: PLC025
GAC   : CRANK
LINECM: PLC025
LINETO: PLC025
LOGAX : PLC025
MARGIN: PLC025
MOVECM: PLC025
MOVETO: PLC025
OFNEF : PLC025
PLCTAB: PLC001 PLC002 PLC025
PLINIT: PLC001 PLC002 PLC025
PLLIM : PLC025
PLMOVE: PLC025
PLNEW : PLC025
PLRSET: PLC025
PLSTOP: PLC001 PLC025
PLSYMB: PLC025
XCCORD: PLC025
XSCAL : PLC025
XSCORD: PLC025
XYAX  : PLC025
XYCURV: PLC002 PLC025 XYC019
YCCORD: PLC025
YSCAL : PLC025
YSCORD: PLC025
```

Referenced COMMON Blocks

E.g. /XYC019/ is referenced by SUBR. XYCURV.

```
CRANK : GAC
PLC001: PLCTAB PLINIT PLSTOP
PLC002: PLCTAB PLINIT XYCURV
PLC025: ARCORN AREA   ASPLIT LINECM LINETO LOGAX  MARGIN MOVECM
        MOVETO OFNEF  PLCTAB PLINIT PLLIM  PLMOVE PLNEW  PLRSET
        PLSTOP PLSYMB XCCORD XSCAL  XSCORD XYAX   XYCURV YCCORD
        YSCAL  YSCORD
XYC019: XYCURV
```

Contents of COMMON /PLC001/

IACTIV - status flag = 0 or 1
= 0: no plotting active
= 1: plotting active
set by : PLINIT (=1), PLSTOP (=0), PLCTAB (=0)
used by: Application programs

Contents of COMMON /PLC002/

SYMHGT - symbol height in centimetres
SYMWID - symbol width in centimetres

Note - do not confuse these parameters with CHCHGT and CHCWID in COMMON /PLC025/

set by : PLINIT
used by: XYCURV

Contents of COMMON /PLC025/

IDEV - device number = 1, 2, ..
set by : PLINIT
used by: LINECM LINETO MOVECM MOVETO
PLMOVE PLNEW PLRSET PLSTOP
PLSYMB

IPFLAG - plot enable flag, if .FALSE. actual plotting should be inhibited
set by : PLINIT
used by: LINECM LINETO MOVECM MOVETO
PLMOVE PLNEW PLRSET PLSTOP
PLSYMB

XLAST - current X-coord. for active device (hardware dependent, if active device operates on integer coord., e.g. TEKPOINTS at the low software level, then current X-coord. will be obtained as IFIX(XLAST)
set by : LINECM LINETO MOVECM MOVETO

PLINIT

YLAST - XLAST's counterpart for the Y-direction

XCMINL, ..., YCMAXL - plot limits in centimetrs
set by : PLINIT PLLIM
used by: LINECM MOVECM XSCAL YSCAL

XSMINL, .., YSMAXL - plot limits in engineering units
set by : PLINIT XSCAL YSCAL
used by: LINETO MOVETO

XCO, YCO - offset and L.L.C. of plotting area
set by : AREA PLINIT
used by: LINECM MOVECM XCCORD XSCAL
XYAX YCCORD YSCAL

DEVSCA - scale factor relating centimetre coord. to screen coord.
set by : PLINIT
used by: LINECM LINEXY LINEY MOVECM XCCORD XSCAL XSCORD YCCORD YSCAL YSCORD

XSO - bias in engineering units
set by : PLINIT XSCAL
used by: LINETO MOVETO XSCORD XYAX

XSSCAL - scale factor relating engineering coord. to screen coord.
set by : PLINIT XSCAL
used by: LINETO LINEXY LINEY MOVETO XCCORD XSCORD

YSO, YSSCAL - see XSO and XSSCAL replace (XCCORD,XSCORD) by (YCCORD,YSCORD)

CHCHGT - height of one character, measured in centimetres
set by : PLINIT
used by: OFNEF XYAX XYCURV PLSYMB

CHCWID - width of one character measured in centimetres
set by : PLINIT
used by: OFNEF XYAX XYCURV

AXCLNG, AYCLNG - lengths of sides of plotting area
set by : AREA PLINIT
used by: LOGAX XSCAL XYAX YSCAL

XSBEG - expresses value in engineering units of plot variable at first scale mark
set by : PLINIT XSCAL
used by: XAXIS

YSBEG - XSBEG's counterpart for the Y-direction replece XAXIS by YAXIS

Note: The coord. pairs (XSO,YSO) and (XCO,YCO) correspond to

the same screen coord., so in order for this to hold, calls to SUBR. XSCAL and YSCAL should follow a call to SUBR. AREA. Screen coord. are computed as X(SCREEN) = (XS+XSO) * XSSCAL = (XC+XCO) * XCSCAL.
XS denotes an engineering coord., while XC denotes a centimetre coord.